Staffing and Equipping Emergency Medical Services Systems:

Rapid Identification and Treatment of Acute Myocardial Infarction

NATIONAL INSTITUTES OF HEALTH
National Heart, Lung, and Blood Institiute

STAFFING AND EQUIPPING EMERGENCY MEDICAL SERVICES SYSTEMS:

Rapid Identification and Treatment of Acute Myocardial Infarction

National Heart Attack Alert Program (NHAAP)

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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FOREWORD

Patients who experience symptoms and signs of an acute myocardial infarction (AMI) should ideally receive treatment within the first hour after the onset of symptoms.

Treatment within the first hour provides an opportunity for the early administration of thrombolytic therapy for eligible patients, thus achieving maximal myocardial salvage. After the first hour, the benefit to be derived from thrombolytic therapy begins to decline rapidly, although benefit can be derived up to 12 hours after symptom onset. Out-of-hospital sudden cardiac death also is an ever-present threat, further highlighting the importance of the first hour from symptom onset to treatment.

A fundamental barrier to timely treatment is delay—at the level of the patient, the emergency medical services (EMS) system, and the emergency department. In June 1991, the National Heart, Lung, and Blood Institute launched the National Heart Attack Alert Program (NHAAP) to address delays in identifying and treating patients with AMI, including sudden cardiac death, with the overall goal of reducing AMI morbidity and mortality. The NHAAP Coordinating Committee was formed to help develop, implement, and evaluate the program. This committee is composed of representatives from 39 national scientific, professional, governmental, and voluntary organizations that are committed to the program goal.

To address the many educational issues associated with the overall goal of reducing delay in the identification and treatment of AMI, the NHAAP has developed objectives for each of three “phases” where delays can occur: the patient/bystander recognition and action phase, encompassing the behavior of patients and those around them in response to symptoms and signs of an AMI; the prehospital phase, incorporating the action taken by the emergency medical services system, including prehospital providers; and the hospital action phase, encompassing efforts of emergency department professionals in identifying and treating patients who present with a possible AMI. Because of the critical importance of time on AMI morbidity and mortality, an overall aim of the NHAAP is to reduce delays associated with these phases through professional, patient, and public education. Reducing the time from the onset of AMI symptoms and signs to the administration of definitive therapy (e.g., thrombolysis) will serve the broad program goal of reducing AMI-related morbidity and mortality.

This paper reviews the integral role of the EMS system in the “chain of survival” for individuals who develop cardiac arrest. It then extends the chain of survival approach to the prehospital management of individuals with symptoms and signs of an AMI. Finally, the current configuration, staffing, and equipping of EMS systems in the United States are reviewed in the context of improving prehospital emergency cardiac care.

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American Academy of Insurance Medicine
American Association of Critical Care Nurses
American Association of Occupational Health Nurses
American College of Cardiology
American College of Chest Physicians
American College of Emergency Physicians
American College of Occupational and Environmental Medicine
American College of Physicians
American College of Preventive Medicine
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American Hospital Association
American Medical Association
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American Public Health Association
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Department of Veterans Affairs
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Health Care Financing Administration
Health Resources and Services Administration
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National Association of Emergency Medical Technicians
National Association of EMS Physicians
National Association of State Emergency Medical Services Directors
National Black Nurses' Association, Inc.
National Center for Health Statistics
National Heart, Lung, and Blood Institute
National Highway Traffic Safety Administration
National Medical Association
NHLBI Ad Hoc Committee on Minority Populations
Society for Academic Emergency Medicine
Society of General Internal Medicine

INTRODUCTION

Cardiovascular disease claims the lives of almost a million Americans each year.[1-3] Approximately 1,250,000 acute myocardial infarctions (AMI's) occur in the United States annually, leading to 500,000 deaths, of which about one-half (250,000) occur suddenly (within 1 hour of the onset of symptoms), frequently outside of the hospital.[1-3] Patients with an AMI, including those with cardiac arrest, thus frequently present to emergency medical services (EMS) systems and providers for transportation and care.

The purpose of this report is to review the role of the EMS system as part of the "chain of survival" for individuals who develop an AMI and/or cardiac arrest in the community setting. The current configuration, staffing, and equipping of EMS systems in the United States are reviewed, and recommendations are made on ways to improve prehospital emergency cardiac care (ECC).

THE "CHAIN OF SURVIVAL" CONCEPT

The onset of AMI symptoms usually occurs when the patient is in the community, outside of a hospital environment. Treatment of an AMI with thrombolytics, aspirin, beta-blockers, and early revascularization can reduce mortality and morbidity, but the likelihood of benefit diminishes over time.[4-6] Because patients with an AMI are at the highest risk of sudden death in the first 1 or 2 hours after symptom onset,[4,6-8] early intervention is highly desirable.

EMS systems should provide rapid monitoring, stabilization, and transfer to the hospital for patients who manifest symptoms or signs of acute cardiac ischemia. Although the safety and efficacy of prehospital thrombolysis is still uncertain,[7-11] paramedics who are trained and equipped to perform 12-lead electrocardiograms (ECG's) in the field can provide the hospital emergency department with information that can rapidly accelerate the administration of these agents after the patient's arrival at the emergency department.[12-15]

Rapid, state-of-the-art treatment is even more important for a victim of an out-of-hospital cardiac arrest. Survival from cardiac arrest is extremely time dependent. Witnessed cardiac arrest victims have a significantly better survival rate than those who suffer unwitnessed cardiac arrest. The shorter the response time, the greater the chance of long-term survival. Therefore, most survivors of cardiac arrest are from the group of patients whose collapse is witnessed by a bystander, who receive cardiopulmonary resuscitation (CPR) within 4 to 5 minutes, and who receive advanced life support (ALS) care (e.g., defibrillation, intubation, drug therapy) within the first 10 minutes.[16]

The American Heart Association has recently proposed the concept of a chain of survival for victims of cardiac arrest.[17] The chain of survival includes four components:

1. Early access to the EMS system
2. Early CPR either by bystanders or first-responder rescuers
3. Early defibrillation by first responders, emergency medical technicians (EMT's), or paramedics (and including nurses and physicians if they are on the scene)
4. Early ALS.

Each link in the chain must be strong to assure maximal survival rates for those who experience out-of-hospital cardiac arrest.

Early Access

Early access to emergency care is facilitated when there is a 9-1-1 system that allows callers to obtain police, fire, or EMS assistance by calling a single telephone number. A popular variant is the enhanced 9-1-1 system that pinpoints the address of the calling phone on the public safety answering point (PSAP) computer terminal the moment the call is received, speeding EMS response and reducing errors. Medical emergency calls received by PSAP's are immediately switched to EMS dispatch centers that ideally should be staffed by trained emergency medical dispatchers (EMD's) who can provide prearrival instructions to the caller, such as prompting bystanders to initiate CPR.

Early CPR

Early CPR provides life-saving cerebral and coronary blood flow during cardiac arrest and thus buys additional time until the rescuers can respond and provide defibrillation and other advanced techniques to restart spontaneous circulation. Trained EMD's can prompt callers with previous training to perform CPR and can effectively teach untrained callers how to do CPR over the telephone. They can significantly increase the number of CPR-trained bystanders who will actually initiate the procedure prior to EMS arrival on scene.[17-21] Dispatchers can also send a first responder (often a firefighter, police officer, or volunteer) to the scene to provide assistance until the ambulance team arrives.

Early Defibrillation

Early defibrillation is essential. The earlier the victim is defibrillated, the greater the chance of survival.[17] Automated external defibrillators (AED's) now permit basic-level EMT's and first responders—as well as the traditional ALS (paramedic) providers—to defibrillate the victim. (See figure 1 for an illustration of an AED.)

The importance of early defibrillation has been emphasized in a number of recent publications.[22-32] Initially, early defibrillation was performed by paramedics, nurses, or physicians. However, there were extreme logistical problems in the rapid delivery of defibrillation because of the limited numbers of these personnel in the prehospital environment. Subsequent research—for example, in King County, Washington State, and the State of Iowa—showed that EMT's could perform defibrillation with minimum training.[33-40] This has allowed an expansion of the concept of early defibrillation because there are approximately 40 times as many EMT's in the United States as paramedics.

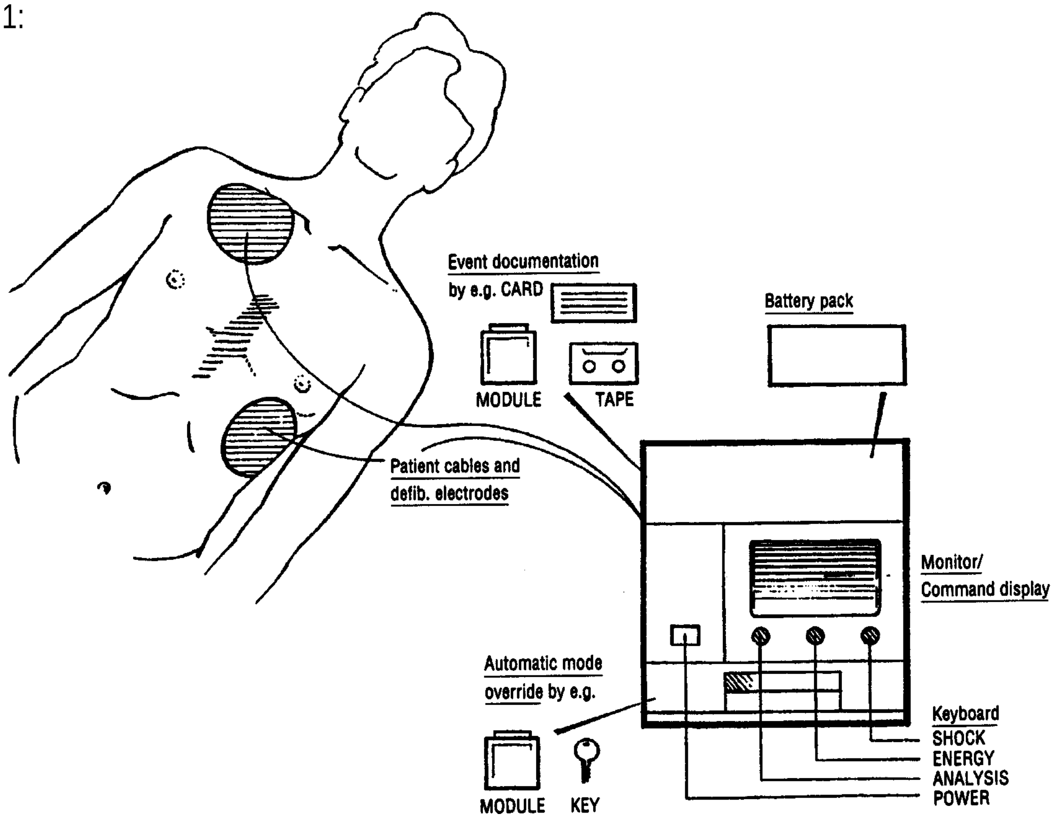
Technological advances in microprocessors have made possible the development of automated defibrillators that can either be implanted permanently or used as external devices similar to a standard defibrillator. With the use of AED's, the concept of early defibrillation can be further expanded, as described in a new chapter in the American Heart Association's *Textbook of Advanced Cardiac Life Support*, which contains an instructor's guide and slides for adding the concept of automated defibrillation to the advanced cardiac life support (ACLS) course.[23]

AED's have been shown to be both effective and safe.[33,34,36-41] As EMS systems have pointed out, time is critical in determining patient survival from cardiac arrest. AED's can quickly and accurately analyze the rhythm, charge the defibrillator, and deliver a shock to the patient. Pilot studies have shown that with minimal training (4 to 10 hours), both EMT's and first responders can reliably and safely defibrillate patients with these automated devices.[35,39,42-47] (See box 1 for a discussion of the various types of AED's and how they operate.)

AED's have been shown to increase resuscitation rates in rural as well as urban areas. Both the King County and Iowa data have shown improvement in resuscitation rates in these areas.[30,31] In Dallas, the resuscitation rates in some fire districts increased threefold—to greater than 10 percent survival for all cardiac arrests (21 percent of ventricular fibrillation patients).[41]

The cost-effectiveness of placing AED's in many different situations has not been determined. Placing these devices in low-risk areas such as a small office

Figure 1:



Reproduced with permission. Textbook of Advanced Cardiac Life Support, 1987, 1990. Copyright American Heart Association.[23]

Box 1:

Types of AED's and how they operate:

Several different varieties of AED devices are on the market. Some are fully automatic: when the on button is pressed, the device analyzes the electrocardiogram (ECG), arms itself, shocks, and then reanalyzes and repeats the sequence if indicated. Other shock-advisory or semiautomatic devices can be placed in analyze mode to examine the cardiac rhythm and prompt the rescuer that defibrillation is indicated. These devices require the rescuer to press a button to deliver the electrical current. Still other devices have the ability to change the energy delivered by pressing a button, while others do it automatically.

All of these devices have paste-on electrodes, which must be applied before use. Once the electrodes are in place, the device is turned on or activated. The device then checks the electrode resistance. If the electrodes are not making good contact, the device gives a visual or verbal signal to check the electrodes. Some devices also look for variations in resistance due to patient movement or breathing; these devices do not activate if there are major variations in resistance. Once the machine has checked the electrode contact, the ECG is analyzed. The machines can reliably tell the difference between medium and coarse ventricular fibrillation and other cardiac rhythms. Once the machine has determined ventricular fibrillation, the defibrillator is armed or charged. After charging the defibrillator, some machines automatically discharge, while others give a visual or verbal signal to press a button to shock. Algorithms can be programmed into some of the machines; for example, some of the machines automatically shock by the system's algorithm (first shock, 200J; second shock, 200J; third and subsequent shocks, 360J). The machines record the timing of events and ECG strips either before and after the defibrillation or continuously.

may not be cost effective, for example, because only one in several hundred such offices may ever have a cardiac arrest. Other placements are cost effective, such as on a first-responder vehicle (police or fire service) that may handle 10 to 20 cardiac arrests per year.[48,49] The prehospital system should examine the potential use of the device and the expected survival that can be estimated from several previous studies in order to make decisions on the proper use of these devices within local areas. To illustrate, a community's ambulance takes 7 minutes to get to an area of town, while the first responder may arrive in 3.5 minutes. The town averages nine cardiac arrests per year. Based on the data from Seattle and King County, the expected survival rate is one patient with paramedic ambulance defibrillation only; but the expected survival rate with first-responder defibrillation is two patients. Hence, an automated defibrillation program can be expected to save one additional life per year. As the devices are used over 7 years, the cost per year is $1,000. Therefore, the incremental cost of such a program is $1,000 per life saved, and this is a cost-effective program. But if a similar community has one cardiac arrest every 7 years, that means that an extra life is saved every 63 years, and the cost of such a program is $63,000 per life saved. This type of planning process should be done to determine the cost-effectiveness and feasibility of any program.

Automated defibrillators can be an adjunct to strengthen the chain of survival, depending on the configuration and response times of individual EMS systems. However, there must be careful planning and medical direction of the program to have a significant benefit from the use of these devices. For example, equipping fire fighter first responders with AED's may be of benefit if they arrive significantly earlier than the ALS ambulance. In other words, it may not be possible to demonstrate substantial benefit from first-responder defibrillation in fast-responding EMS systems served by paramedics, as demonstrated by Kellermann et al.[50]

Early ALS

Early ALS care with drugs and other therapy further improves the patient's chances for survival.[17,51] This can be provided by paramedics wherever feasible. In areas where paramedics are not feasible because the number of emergency calls is too low to maintain paramedic skills, then rapid transport to the hospital is required so that the hospital can provide the early advanced care. The American Heart Association has estimated that rapid delivery of care could save between 100,000 and 200,000 lives per year.[17,23]

Summary: Chain of Survival

The chain of survival was conceptualized initially for cardiac arrest victims; however, patients with an AMI also benefit from such an approach to ECC in the community. Early EMS access is of benefit to the patient with an AMI by providing stabilization and rapid transport of the patient to the hospital where thrombolytic therapy and other treatments can be provided. Early CPR and defibrillation can be provided if a cardiac arrest complicates the infarction. Early ALS care for patients with an AMI includes monitoring, I.V. insertion, pain control, antiarrhythmic therapy, and possibly field administration of thrombolytic therapy. Therefore, the concept of the chain of survival is essential not only for the victim of a cardiac arrest but also for the patient with an AMI.

ELEMENTS OF CURRENT EMS SYSTEMS

EMS systems are composed of the personnel, vehicles, equipment, and facilities used to deliver medical care to individuals with an unanticipated, immediate need outside a hospital and continued care once in the emergency facility.

The components of EMS systems include public access, ideally accomplished through a coordinated communications system; prehospital response, incorporating public safety response, EMS professional response, and transportation; and medical response, incorporating the primary, secondary, and tertiary levels of hospital care.[52]

Nationally, there are over 12,000 ambulance services with approximately 35,000 ground ambulances. States have developed regulations and standards for the design of ambulance vehicles and equipment for various EMS personnel and services.[52]

Air medical transport by fixed-wing aircraft (airplanes) and helicopters augment ground ambulance programs and are important modes of transportation in providing early access to care for individuals with symptoms and signs of a heart attack where time, distance, lack of medical personnel, or scene isolation warrant it, as in rural areas.[52]

The levels of service provided by EMS systems vary considerably among States, in large part determined by local or State regulations and the perceived need of the medical community. Each State has an office of emergency medical services (typically under the department of health) that coordinates training and, in most cases, provides regulatory oversight. This entity typically controls the minimum or maximum levels of care that may be provided.

The majority of certified ambulance personnel in the United States are basic EMT's.[52-58] Virtually all States have adapted the U.S. Department of Transportation national training programs for the basic EMT (EMT-Basic) and the EMT-Paramedic (EMT-P). The EMT-Basic training program has been in existence since the first pilot programs in 1968. A national curriculum has been widely distributed and adapted by most States for use since 1972. It is viewed by most State EMS agencies as the minimum acceptable level of training for ambulance attendants. Eleven States do not require EMT training as a minimum to function as an attendant on a public ambulance. An additional three States require EMT-Basic training for paid ambulance attendants but not for volunteers.

The EMT-Basic program contains 110 hours of instructional content. The actual number of course hours varies among States from 104 to 315 hours. A major revision of the EMT-Basic training curriculum is expected to be released during 1993. The national standard curriculum for the EMT-P was last modified and printed in 1985, and no changes are anticipated in the near future. EMT-P training varies among States from 300 to 1,500 hours.

EMS ambulances in urban/suburban areas of the United States are staffed almost exclusively by ALS providers.[59] Some areas staff ambulances with two paramedics; others employ one paramedic and one EMT-Basic provider. Smaller cities and rural areas of the Nation are most often served by a mix of personnel at various levels of training, with the size of the community, the call volume, the number of runs, and the types and numbers of personnel most often the determinants of the level of care provided. Rural and wilderness communities are most often served by volunteer units staffed by a large pool of personnel to ensure coverage for the relatively small call volume that is typical of such services. Because of the high personnel/low call-volume ratio, many of these services remain at the EMT-Basic or EMT-Defibrillator (EMT-D) level due to the difficulty of remaining current and competent in the advanced skills that higher levels of certification entail. In the smallest of communities, it is not uncommon for the ambulance service to use a pool of drivers, with less training than the attendants, to ensure that they have sufficient volunteers to respond to every call for assistance.

A method of response by the closest public safety unit to a medical emergency has been in place around the country for a number of years. It is called tiering and employs layers of medical responders to an emergency. Typically, the first responders are units of police or fire departments that are dispatched as the closest available unit. Their job is to treat and stabilize the patient initially until the arrival of the transporting ambulance and personnel.

Although these first-responder units are predominantly police personnel on patrol or fire service personnel on ready alert, in some circumstances they may be volunteers who have received CPR and first aid training. In some rural areas, the first responders may be EMT-Basic-trained providers who reside too far from town to be available for ambulance duty but can respond to medical calls in their immediate area while awaiting the arrival of their community ambulance. EMT-Basic and EMT-P personnel who function as first responders are generally referred to as basic and advanced "quick responders."

There is substantial State-to-State variability in the titles, training requirements, and skills among different levels of EMT's. For the purpose of the recommendations in this section, ALS providers are defined as individuals who possess the training, skills, and certification to perform all of the procedures covered in the American Heart Association's ACLS course.[23] In some States, this definition may encompass some of the intermediate levels of EMT's as well as paramedics.

Cost-benefit considerations, skill retention by prehospital care providers, and practicality have to be considered in making any recommendations on the minimum level of care and equipment that are appropriate in the EMS environment. For example, it would be medically optimal if every community in the United States were covered by first responders trained and equipped to defibrillate, with a paramedic-level ALS crew arriving at 90 percent of all high-priority emergency cardiac calls in less than 9 minutes (typically resulting in a median response-time interval of 5 minutes). However, communities should contemplate adopting such a system only if it results in significantly earlier arrival of first responders, as noted. The demographics of the population being served and attendant clinical conditions likely to occur with greater frequency (e.g., the likelihood of witnessed ventricular fibrillation in an older versus a younger population) are planning considerations for these systems. Also, general recommendations that may be suitable in most urban and suburban environments must often be modified to meet the special needs of the highly congested urban area and the remote rural location. Traffic may prevent rapid emergency response in the former, and geographic distance and difficulties in recruiting, training, and maintaining ALS skills in volunteer rescue services may encumber the latter.

Despite these exceptional situations, it must be stressed that the recommendations that follow should apply to the majority of locations in the United States. In all but the most remote wilderness locations, the median response-time interval (time from call receipt by the emergency dispatcher until the ambulance is on location) is typically comparable in rural, suburban, and urban areas. Median response-time intervals in rural locations are generally very similar to those in most urban or suburban locations because most rural residents in the United States live within a 5- to 6-minute drive of the county seat (where the EMS ambulance is usually based). Thus, the recommendations should be viewed as guidelines that must be adjusted to meet the local situation.

Recommendations for EMS Systems Configuration and Staffing

9-1-1. Implementation of universal 9-1-1 and enhanced 9-1-1, where feasible, should be promoted nationally to ensure rapid access to EMS. A separate paper addressing the importance of 9-1-1 availability for early access to cardiac care has been developed.[60]

Emergency Medical Dispatching. Dispatch centers should be staffed by properly trained EMD's, who should be under medical direction. Medical dispatchers should be capable of delivering standardized prearrival instructions. A separate paper addressing the potential role of emergency medical dispatching in providing early cardiac care has been produced.[61]

First-Responder Coverage. Survival from out-of-hospital cardiac arrest can potentially be improved significantly in urban, suburban, and rural locations when first responders can respond quickly to the scene and can provide defibrillation using AED's—although, as noted, it may not be possible to demonstrate substantial benefit from first-responder defibrillation in fast-responding EMS systems served by paramedics. However, given the importance of early defibrillation for survival of cardiac arrest, it appears reasonable to support the position taken by the American Heart Association Emergency Cardiac Care Committee regarding first-responding emergency personnel:[62]

> To achieve the goal of early defibrillation, the American Heart Association endorses the position that all emergency personnel should be trained and permitted to operate an appropriately maintained defibrillator if their professional activities require that they respond to persons experiencing cardiac arrest. This includes all first-responding emergency personnel, both hospital and nonhospital (e.g., emergency medical technicians [EMT's], non-EMT first responders, firefighters, volunteer emergency personnel, physicians, nurses, and paramedics).
>
> To further facilitate early defibrillation, it is essential that a defibrillator be immediately available to emergency personnel responding to a cardiac arrest. Therefore, all emergency ambulances and other emergency vehicles that respond to or transport cardiac patients should be equipped with a defibrillator.

There need to be sufficient first-responder units deployed in the community at all times to ensure a rapid response to all life-threatening calls. As a rule of thumb, a first responder should arrive at the scene less than 5 minutes from the time of dispatch in 90 percent of all such calls. This will generally result in a median first-responder response time of 2 to 3 minutes.

First responders should be qualified through their respective police or fire service on the basis of successful completion of first-responder training approved by the State EMS director. Schoolteachers, security officials, industrial supervisors, flight attendants, and many other individuals should be considered as potentially suitable for first-responder training.

The American Society for Testing and Materials (ASTM) has developed practice standards for the performance of prehospital manual (ASTM designation 1254-90) and prehospital automated (ASTM designation F 1255-90) defibrillation. These documents establish minimum guidelines for defibrillation in the prehospital setting. EMS institutions, organizations, and certification/licensing agencies (particularly State EMS directors) are encouraged to develop standards for the certification, licensing, and practice of prehospital defibrillation by first responders.

ALS Coverage. Over 98 percent of the 200 most populous cities in the United States provide at least some degree of ALS care, and the trend over the last 5 years has been for more ALS coverage.[59] There is better survival from out-of-hospital cardiac arrest in systems that provide ALS care compared to the survival in systems that can only provide CPR and defibrillation.[63-70] ALS is the optimal level of care in urban and suburban locations where the call volume is sufficient to maintain ALS provider skills (at least 500 to 1,000 calls per year).

A subject of controversy within the EMS community is whether busy EMS systems should staff all ambulances with ALS providers (all-ALS system) or with a combination of ALS and basic life support (BLS) crews (tiering). This practice varies regionally and should be determined based on the economics and logistics of a given EMS area. It has been argued that tiering the response into BLS and ALS ambulances saves little in cost and creates a potential “failure point” in the system by forcing the dispatcher to triage calls based on incomplete, often inaccurate, information.[49] An all-ALS system reduces the risk by guaranteeing that all patients will be assessed and treated by an individual who has the highest level of skill in the prehospital profession. In fact, Wilson et al.[71] showed that despite the use of strict dispatching protocols, nearly 12 percent of patients prioritized as non-emergent unexpectedly required ALS care after evaluation by ALS personnel. On the other hand, ALS providers in tiered systems may get to practice their advanced skills more frequently, providing a theoretical advantage in terms of ALS skills maintenance. The decision to tier, or not to tier, is generally made locally based on medical, practical, historical, educational, logistical, and economic considerations.

Regardless of the EMS system’s design, there need to be sufficient ALS units deployed in populous communities to ensure a rapid response to all emergency, top-priority calls at all times. As a rule of thumb, 90 percent of all top-priority emergency calls in all sectors of a city should receive an ALS response to the scene in less than 9 minutes from the time of call dispatch. This generally results in a median ALS response time of 4 to 5 minutes.

Recommendations for Ground Ambulance Design

The current KKK-A-1822C Federal specifications for ambulances are appropriate and should be met by all EMS ambulances. In addition, all emergency ambulances and other emergency vehicles that respond to or transport cardiac patients should be equipped with a defibrillator as noted.

Recommendations for Prehospital 12-Lead Electrocardiography

It has been firmly established that patients receive faster treatment of an AMI with thrombolytic drugs in the emergency department when paramedics perform a 12-lead ECG in the field and transmit the tracing to the hospital by cellular telephone.[12-15] Shorter hospital time delays have been observed for patients whose prehospital identification by history and/or ECG was obtained as part of a protocol-driven prehospital diagnostic strategy and whose diagnosis of AMI was made before arrival at the hospital.[72,73]

Prehospital identification of patients with AMI by 12-lead ECG using cellular telephone transmission has decreased the time to treatment in the emergency department,[72] and its use should be encouraged. Therefore, development of cost-effective, reliable technology and strategies for transmitting the 12-lead ECG from the field to the emergency department should be encouraged.

Recommendations for Thrombolytic Therapy

Thrombolytic therapy can be initiated more quickly in patients with an AMI when paramedics (or, in some other countries, physicians staffing ambulances) initiate thrombolytic therapy in the field.[11,74] However, well-conducted, prospective clinical trials have thus far not demonstrated significant reduction in morbidity or mortality with field thrombolytic administration.[73,74,75] The major problems with prehospital thrombolysis are the cost (e.g., the 12-lead ECG equipment, cellular telephone transmission capability, thrombolytic drug stock in each vehicle, refrigeration equipment) and the potential medicolegal risk of patient selection and drug administration by nonphysicians.[9,10] In most EMS systems, it is more cost effective and beneficial to saturate the community with first-responder defibrillation and ALS backup capability than to add prehospital thrombolysis.[9,10] Thus, prehospital thrombolysis should be considered a desirable option in high-performance EMS systems that have already addressed the basic emergency cardiac care needs of the public.

Equipment manufacturers should be encouraged to develop enhanced platforms that perform multiple functions (e.g., ECG monitor, defibrillator, 12-lead ECG).

Recommendations for Medical Direction and Quality Improvement

The single most important element in any EMS system is strong medical direction by a capable physician or group of physicians with a system for continuous evaluation of the system (quality improvement). The medical direction should be present both online and offline. Online medical direction has been called direct medical control. It entails the provision of direct, immediate, and concurrent orders to prehospital providers. This direct medical direction should be formally delegated by the medical director. Offline medical direction has been called indirect medical control. It refers to the administrative medical direction of EMS personnel by a physician, usually designated by an EMS authority. This direction includes system design, education, critiques, and quality assurance. The physician is usually responsible for developing protocols, ensuring compliance, and certifying providers.[57] It is essential that all elements of the EMS system, including medical dispatch, be under medical direction.[53,57,58]

Recommendations Summary

The EMS system is crucial to the rapid identification and treatment of patients with symptoms and signs of AMI. To achieve the goal of reducing morbidity and mortality from heart attacks, it is recommended that:

1. The chain of survival concepts should be applied universally to patients with cardiac arrest. In addition, many of these concepts should be applied in the community to the rapid identification and treatment of AMI.

2. Universal 9-1-1 should be a national goal and enhanced 9-1-1 should be implemented wherever feasible nationally.

3. EMD’s should be properly trained, operate under medical direction, and should be capable of delivering standardized prearrival instructions.

4. Federal specifications for ambulances (KKK-A-1822C) should be met by all EMS ambulances.

5. All emergency medical personnel, including first responders, should be trained to operate defibrillators, and all emergency medical vehicles should be equipped with defibrillators (manual or AED’s).

6. Regardless of EMS system configuration, all communities should have sufficient EMS coverage by ALS-trained personnel and ALS-equipped vehicles to ensure a rapid response to all top-priority emergency calls at all times.

7. Medical direction of EMS systems should be present both online and offline, and all elements of the ECC systems, including emergency medical dispatch, should be under medical direction. At the same time, it is recognized that online medical direction is not always possible in rural areas.

8. EMS systems should consider providing prehospital 12-lead ECG’s to facilitate early identification of AMI. All ALS vehicles should ideally have the capability to transmit a 12-lead ECG to the hospital.

9. EMS systems that have already achieved these recommendations may also wish to consider administering prehospital thrombolytic therapy. It should be stressed that it is an option for high-performance systems that have already addressed the basic chain of survival cardiac care needs of the public.

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